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# INTEGRATED PIXEL STRUCTURE, INTEGRATED TOUCH PANEL LCD DEVICE AND METHOD OF CONTROLLING THE SAME

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to Taiwan Patent Application No. 97132521 entitled "INTEGRATED PIXEL STRUCTURE, INTEGRATED TOUCH PANEL LCD DEVICE AND METHOD OF CONTROLLING THE SAME", filed on Aug. 26, 2008, which is incorporated herein by reference and assigned to the assignee herein.

## FIELD OF INVENTION

The present invention relates to a touch panel liquid crystal display (LCD) device, and more particularly to an integrated touch panel LCD device and a method of controlling the same.

## BACKGROUND OF THE INVENTION

Comparing with the traditional input devices, such as keyboards and mice, the touch panels have advantages of space saving and simple humanization operation interface.

The conventional LCD device with touch-sensitive function is usually configured in a plug-in way, in which a touch panel is stacked on a LCD panel directly. FIG. 1 is a side cross-sectional view of a conventional touch panel LCD device 100, primarily including a touch panel 110 and a LCD panel 120. Generally speaking, a touch region 112 corresponding to the display region 125 of the display panel 120 is disposed in the center of the touch panel 110, and a detecting circuit 114 is disposed in the peripheral of the touch panel 110. When an object touches the touch region 112, an electrical signal is generated correspondingly and then transmitted to other circuit on the circuit board 130 through a connector 132 for the further process.

Besides, in order to increase stability and reduce vibration, a plastic buffer pad 140 is usually placed between the touch panel 110 and the LCD panel 120, and then a housing 150 is adopted for fixing all elements. Therefore, the conventional plug-in touch panel LCD device is inconvenience for users due to the increased thickness and weight. Furthermore, in addition to the problems of the decreased brightness and the increased reflectivity, the air gap between the touch panel 110 and the LCD panel 120 may cause some color non-uniformity defects (Mura), such as the Newton ring effect.

Therefore, it is desired to have a lightweight and reliable touch panel LCD device.

## SUMMARY OF THE INVENTION

In light of the problems of the prior art, the present invention provides an integrated touch panel LCD device and a method of controlling the same, which possesses the advantages of customization, lightweight, no air gap, and multi-touch function.

According to one aspect of the present invention, an integrated pixel structure is provided. The integrated pixel structure of the present invention includes a transistor matrix substrate, a color filter substrate, and a liquid crystal layer. The color filter substrate is disposed above the transistor matrix substrate, and is substantially parallel with the transistor matrix substrate. The liquid crystal layer is interposed

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between the transistor matrix substrate and the color filter substrate. The transistor matrix substrate includes a first transistor, a first storage capacitor connected to the first transistor, a second transistor, a second storage capacitor connected to the second transistor, and a conductive protrusion. The conductive protrusion is disposed corresponding to the second storage capacitor, and configured to electrically connect the second storage capacitor and the color filter substrate when the color filter substrate is pressed.

According to another aspect of the present invention, an integrated touch panel LCD device is provided. The integrated touch panel LCD device of the present invention includes a liquid crystal panel, a gate driving circuit, a data driving circuit, a touch reading circuit, and a comparison circuit. The liquid crystal panel includes a plurality of integrated pixel structures of claim 1, a plurality of gate lines, and a plurality of data lines. The gate driving circuit is configured to output a control signal to the plurality of gate lines. The data driving circuit is configured to output display data and touch reference data to the plurality of data lines. The touch reading circuit is coupled to the plurality of data lines for reading data stored in the second storage capacitors of the plurality of integrated pixel structure. The comparison circuit is coupled to the touch reading circuit for receiving and calculating the stored data to obtain touching information corresponding to a touch position on the liquid crystal panel.

According to still another aspect of the present invention, a method for controlling an integrated touch panel LCD device is provided. The integrated touch panel LCD device includes a liquid crystal panel which includes a plurality of integrated pixel structures of claim 1, a plurality of data lines, and a plurality of gate lines. The method of the present invention includes the steps of: transmitting display data to the first storage capacitors for updating a display image of the liquid crystal panel; transmitting touch reference data to the second storage capacitors; reading data stored in the second storage capacitors; and calculating the stored data to obtain touching information corresponding to a touch position on the liquid crystal panel.

Other aspects of the present invention would be stated and easily understood through the following description or the embodiments of the present invention. The aspects of the present invention would be appreciated and implemented by the elements and their combinations pointed out in the appended claims. It should be understood that the above summary of the invention and the following detailed description are only illustrative but not to limit the present invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

The drawings are employed to illustrate the embodiments and the principles of the present invention in conjunction with the description. However, it should be understood that the present invention is not limited to the shown configurations and elements, in which:

FIG. 1 is a cross-sectional view of a conventional touch panel;

FIG. 2 is a circuit diagram of one integrated pixel structure of an integrated touch panel LCD device according to an embodiment of the present invention;

FIGS. 3A and 3B are cross-sectional views of the touch unit in FIG. 2 according to two different embodiments of the present invention respectively;

FIG. 4A illustrates various structures of the conductive protrusion in FIGS. 3A and 3B;

FIG. 4B depicts different combinations of the conductive protrusion and the spacer in a pixel;